

INSECTICIDAL EFFICACY OF SPINETORAM, CHLORFENAPYR AND CYPERMETHRIN AGAINST *Tribolium castaneum* (HERBST) (COLEOPTERA: TENEBRIONIDAE)

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Red flour beetle is the most multi-ethnic pest having general involvement with human beings and their food stuff. This study was planned to investigate the insecticidal efficacy of cypermethrin, spinetoram and chlorfenapyr against *Tribolium castaneum* (Herbst) under laboratory conditions. The insecticides were used at three different concentrations i.e., 5, 7 and 9ppm. The overall results regarding the comparative effect of different insecticides showed that cypermethrin was the most effect having highest mortality value 78.71%, followed by chlorfenapyr with mortality value 64.38%. In case of spinetoram the lowest value of mortality 52.86% was observed. Results regarding the effect of different concentrations showed that there was a gradual increase in mean percent mortality with increase in concentration of insecticides for against *T. castaneum*. Similarly, the results about the effect of time period showed that there was increase in mortality with the increase in exposure period. After 24hs of exposure period the mortality was 55.59% and after 48hrs the mortality value was 60.77%. After 7 days the highest mortality (75.85%) was recorded.

Keywords: *Tribolium castaneum*, toxicity, cypermethrin, chlorfenapyr, spinetoram..

INTRODUCTION

Food demands will be increase about to 60% due to increasing in population and distribution in 2050 (Alexandratos and Bruinsma, 2012). Then, reduction in post-harvesting losses is a critical component for filling the demands of population. Because a large number of food security issues can be facing in the future.

The storage of grains and their products with respect to insect invasion is a severe problem at global level. An annual storage loss of stored cereals owing to different factors ranges from 10 to 20% (Phillips and Throne, 2010). In Pakistan, about 4-10% storage losses of food grains occur due to insect pests attack (Huque *et al.*, 1969). Among these storage insect pests, Red flour beetle, khapra beetle, lesser grain borer and weevil species are of economics importance (Arbogast, 1991). Their attack makes the grains inedible due to diminution of unambiguous nutrients (Jood and Kapoor, 1994).

Red flour beetle [*Tribolium castaneum* (Herbst)] is the most multi-ethnic pest having general involvement with human beings stored grains and their products (Via, 1999). *T. castaneum* breeds throughout the year and adults are damaging to grain commodities stored in area with warm temperature (Pugazhvendon *et al.*, 2009). It has extended life span of two or more years in which one female is capable of laying up to 1000 eggs. It is a cosmopolitan insect and it is very difficult to control in stored grain insect pest other than

stored product insects by using insecticide (Arthur, 2009). Storage environment also effected the development of stored grain insect pest. Because refugial areas are present in the stored houses due to which insects can escape from the exposure of insecticide and accumulated food material also assist to continue for the development of insect species (Campbell *et al.*, 2010; Toews *et al.*, 2010). In severe infestation, *T. castaneum* causes substantial loss in stored grain commodity due to its high reproductive potential (Prakash *et al.*, 1987). Attack of this pest has been resulted into 34 to 40% losses during storage (Ajayi and Rahman, 2006).

For the control of insect infestation, the use of conventional insecticides and fumigants are the main method of grain production because of being simplest and cost effective (Hidalgo *et al.*, 1998), but the wild spread use of these pesticides have considerable side effects including; resistance development, environmental pollution, handling hazards, residues contamination and lethal effects on non target organisms (Zettler and Cuperus, 1990). One of the ways to control the problem of insecticide resistance of stored grain insect pests to different insecticides and to minimize selection pressure in insects is the use of new chemistry insecticides. The latest studies show that the insecticides like spinetoram, chlorfenapyr provide more effective control as compared to conventional pesticides (Arthur *et al.*, 2004; Kavallieratos *et al.*, 2009).

Keeping in view the above facts, the current investigation was designed to study the insecticidal efficacy of spinetoram, chlorfenapyr and cypermethrin against *T. castaneum*.

MATERIALS AND METHODS

Insect Material: Mixed age culture of *T. castaneum* was collected from grain market as well as from go downs of Punjab Food Department located at various districts in Punjab province. The culture of *T. castaneum* was reared on wheat flour, apparently free from insect infestation. The population was reared in glass jars, each containing one kg of sterilized wheat grains/flour. The open ends of jars were covered with muslin cloth and placed in the laboratory at $30\pm 2^{\circ}\text{C}$ and $65\pm 5\%$ relative humidity with a photoperiod of 16:8, L:D. From these heterogeneous cultures, collected from various destinations, red flour beetle pupae were separated and kept in an incubator at optimum conditions for adult emergence, which were used for mass rearing and getting homogenous populations after 24-48h. The hundred adult beetles were released on the rearing medium in the jars. After seven days, beetles were sieved out from the rearing medium. Rearing medium along with eggs of these insects were put into jars again and were placed in incubator at optimum growth conditions to get a homogenous population. Later on, uniform sized progeny of these test insects were used for further bioassay studies.

Bioassay: Three different insecticides i.e., Chlorfenapyr (Pirate 360SC), Spinetoram (Radiant 120SC) and Cypermethrin (Cypermethrin 10EC) were used at 5, 7 and 9 ppm concentrations. All tests were performed in incubators set at $28\pm 2^{\circ}\text{C}$ and $65\pm 5\%$ RH. For each treatment there were three plastic jars which were used as replicates. Each jar was filled with 250g of treated kibbled wheat grain and thirty individuals of the test insect were placed into each jar. The jars were placed in incubator at the conditions mentioned above and in continuous darkness. The RH in the plastic containers was continuously monitored. Mortality of exposed individuals was assessed after 24, 48, 72, 96 hours and then after one week. Cracked grains treated with distilled water were used as control. Dead insects were counted for treated and non-treated experiments at same time intervals. Mortality data was corrected using Abbott's formula (Abbott, 1925) if any mortality occurs in the control treatment.

Statistical Analysis: Data was collected for percent mortality. The collected data was analyzed statistically using statistica software. The means of significant treatments were compared using Tukey's HSD test.

RESULTS

Current study was planned to probe the comparative insecticidal effect of spinetoram, chlorfenapyr and cypermethrin against *Tribolium castaneum* (Herbst) under

laboratory conditions. Experiments were conducted under Completely Randomized Design (CRD) with all the treatments replicated thrice along with control. The insecticides were used at three different concentrations i.e., 5, 7 and 9 ppm and data regarding mortality was observed after 24, 48, 72, 96 hr and 7 days of treatment application.

The analysis of variance of data regarding mortality percentage at different concentrations of spinetoram, chlorfenapyr and cypermethrin showed that the main effects, insecticides and concentration have significant effect on mortality of *T. castaneum* after all the exposure periods. Results (Fig.1) revealed that cypermethrin gave highest percent mean mortality 68.89% followed by chlorfenapyr (54.67%) and spinetoram (43.22%) after 24hrs of treatment application. Results regarding the effect of different concentrations showed that mortality was highest 58.41% at 9ppm and was lowest 40.00% at 5ppm concentration after 24hrs of treatment application (Fig. 2).

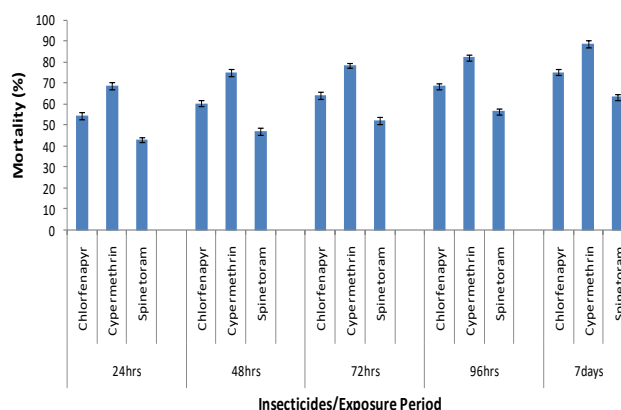


Figure 1. Comparative effect of different insecticides against mortality (%) of *Tribolium castaneum* at different exposure periods.

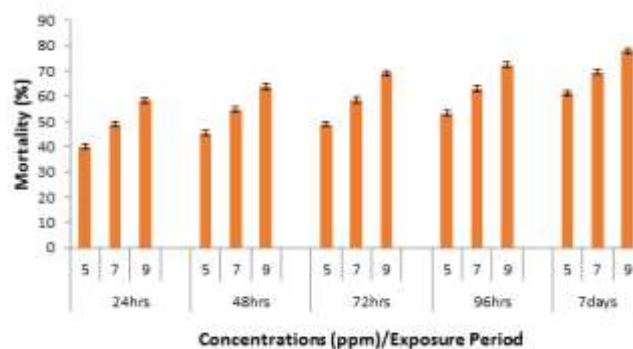


Figure 2. Comparative effect of different concentrations against mortality (%) of *Tribolium castaneum* after different exposure periods.

Similarly, after 48hrs the mortality was 75.00, 60.33 and 47.00% as a result of cypermethrin, chlorfenapyr and spinetoram treatment application, respectively (Fig.1). As for as the effect of concentrations was concerned that maximum mortality 63.91% was recorded at highest concentration 9ppm. After 72hrs of exposure period the mortality was in such order cypermethrin (78.55%) > chlorfenapyr (64.44%) and spinetoram (52.33%) (Fig.1). Results about the effect of concentrations showed that a dose dependent response was observed in mortality of *T. castaneum* (Fig.2). After 96hrs of treatment application the highest mortality was 82.33% in case of cypermethrin followed by chlorfenapyr (68.56%) and spinetoram (56.48%) and the response of concentrations was in the same pattern as for 72hrs treatment. Mortality results after 7days of exposure period showed that cypermethrin gave highest mortality 88.78% and was lowest 63.55% as a result of spinetoram application. In case of chlorfenapyr treatment application the mortality was 75.22% (Fig.1). The response of concentrations to mortality showed that highest mortality 78.08% was recorded at highest concentration (9ppm) and was lowest 61.47% at 5ppm concentration (Fig.2).

The overall results (Fig.3) regarding the comparative effect of different insecticides showed that cypermethrin was the most effect having highest mortality value 78.71%, followed by chlorfenapyr with mortality value 64.38%. In case of spinetoram the lowest value of mortality 52.86% was observed. Results (Fig.4) regarding the effect of different concentrations showed that there was a gradual increase in mean percent mortality with increase in concentration of insecticides for against *T. castaneum*.

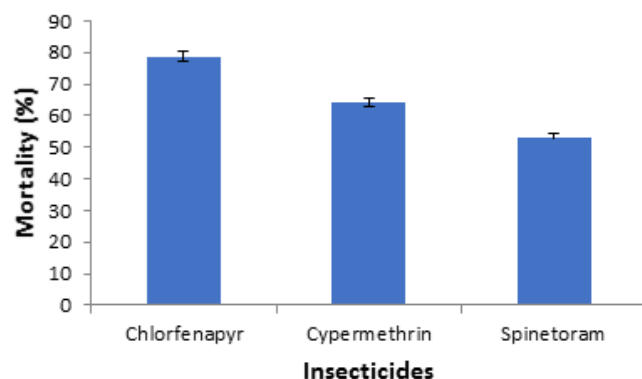


Figure 3. Effect of different insecticides against mortality of *Tribolium castaneum*

The overall results (Fig.5) about the effect of time period showed that there was increase in mortality with the increase in exposure period. After 24hrs of exposure period the mortality was 55.59% and after 48hrs the mortality value was 60.77%. After 7 days the highest mortality (75.85%) was recorded.

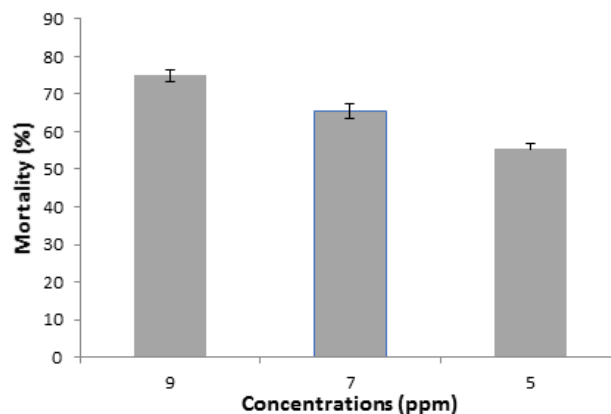


Figure 4. Effect of different concentrations against mortality of *Tribolium castaneum*

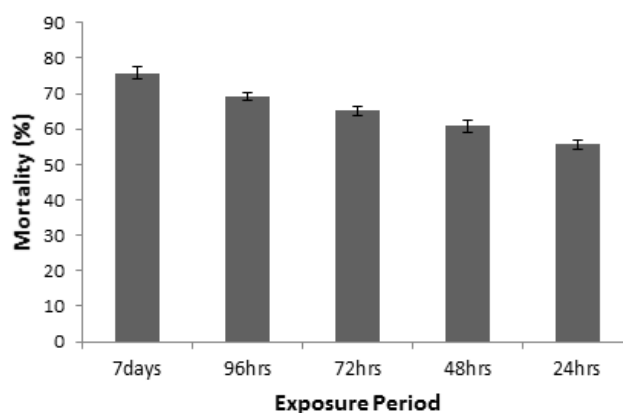


Figure 5. Response of different insecticides at various time periods against mortality of *Tribolium castaneum*.

DISCUSSION

The present study disclosed that maximum adult mean percent mortality of *T. castaneum* was recorded at highest concentration (9ppm) was 78.08% followed by 69.41% at 7ppm and 61.41% mean mortality was recorded at 5ppm. cypermethrin gave highest mortality followed by chlorfenapyr and spinetoram, respectively.

The other aspect covered in the study was evaluating the effect of exposure period on the mortality of *T. castaneum*. Exposure period has significant effect on the mortality on test insect. The mortality obtained for cypermethrin after exposure period of 7 days was highest for against the insect pest of stored commodities. Interaction between insecticides and concentrations were also studied and remained highly significant up to 7 days of exposure.

The results of this study were similar with Arthur *et al.* (2004) concluded that mortality of test insects increases with increase in insecticide concentration and exposure period. Three

insects were tested for mortality including *T. castaneum*, *O. surinamensis* and *S. zeamais*. These insect pests showed different mortality trend against the insecticides, when different concentration was used then various data about mortality obtained. By increasing the concentration of insecticide the mortality of insect pests increased.

Khatun *et al.* (2010) investigated about the insecticidal effect of cypermethrin, nimbecidine and deltamethrin against the *T. castaneum* under the lab conditions. In this experiment the cypermethrin showed significant results about the insect pest of stored grain insect pests. But in our experiments the cypermethrin showed high efficacy against the *T. castaneum*. We observed 88.78% mortality in lab experiment after the 7 days of exposure period.

After the investigation of efficacy of cypermethrin insecticide, the Kavallieratos *et al.* (2016) reported about the effect of chlorfenapyr, pyriproxyfen, spinosad, pirimiphos-methyl and deltamethrin against the larvae of *T. granarium*. The application of chlorfenapyr was resulted in 70% mortality in small larvae. Results revealed that all the insecticides have significant effect except pyriproxyfen. Our results in accordance with Athanassiou *et al.* (2015) showed that the cypermethrin has highly toxicity against the *T. granarium* and *T. castaneum* in storage commodity of warehouses and storage facilities. The adult mortality of *T. granarium* was more on substrate or dishes which treated with alpha-cypermethrin than the other insecticides. After the cypermethrin, chlorfenapyr gave effective control against *T. castaneum*.

Insecticides and concentration interaction results for most of the treatments remained significant. The overall results showed increased mortality with increase in concentration and exposure period.

Conclusion: From these results we can conclude that all the insecticides under study have significant effect on mortality of *T. castaneum*, but cypermethrin and chlorfenapyr were the more effective ones. It should be used as grain protectants to prevent post-harvest losses caused by stored grains insect pests.

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